ABG and Acid-Base Status

By

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INDICATION

- **Oxygenation**
- **Ventilation**
- **Acid-Base Status**

Blood Gas Report

- **pH (No Units) 7.35-7.45**
- **$PaCO_2$ (mm Hg) 35-45**
- **PaO_2 (mm Hg) 110 - 0.5(age)**
- **HCO_3^- (mmol/L): calc. 22-26**
- **B.E. (mmol/L): Nomo. -2 to 2**
- **O_2 saturation: calc. >90%**

ANALYSIS OF OXYGENATION

- **Alveolar Gas Equation**
  - **$PAO_2 = FIO_2(P_B - 47) - 1.2(PaCO_2)$**
  - **PAO_2 defines upper limit of PaO_2**
  - **PAO_2 = 102**
  - **FIO_2 is 21% at all altitudes**
  - **Factor 1.2 determined by RQ varies with FIO_2**
  - **Water vapor pressure = 47 mm Hg**
  - **$PAO_2 = 150 - 1.2(PaCO_2)$ at room air**

Alveolar-Arterial PO_2 Difference

- **A-aDo_2 = PAO_2-PaO_2(from ABG)**
- **Insight in the patients state of gas exchange**
  - **If elevated, defect in gas exchange**
  - **Proper interpretation of the PaO_2**
- **Ideal conditions PAO_2 = PaO_2**
  - **Every alveolus perfectly ventilated**
  - **No diffusion impairment**
  - **All pulmonary capillaries perfused**
  - **No shunt present**

Arterial Oxygen Values

Age	L.L. PaO2	U.L. A-aDo2
20	84	17
30	81	21
40	78	24
50	75	27
60	72	31

- **Max A-aDo2 = 2.5 + Age/5**
- **Hypoxemia PaO2 < 70 (relative)**

Causes of a low PaO_2 and A-a Do_2

- V/Q mismatch
- Shunt
- Diffusion Impairment
- Alveolar Hypoventilation(Nl A-a Do2)
- Decreased mixed venous O_2 content
- P(B): Altitude

Alveolar Hypoventilation

- **Muscle weakness**
- **Neuromuscular Junction Disease**
- **Reduced Respiratory Drive**
- **Chest wall elastic loads**

V/Q Mismatch

- **Asthma**
- **COPD**
- **Pneumonia**
- **Pulmonary Embolism**
- **Pulmonary Edema**

Reduced Diffusion Capacity

- **Interstitial Lung Disease**
- **Pulmonary Edema**
- **Reduced Lung Volume**
- **Emphysema**
- **Pulmonary Resection**
- **Anemia**

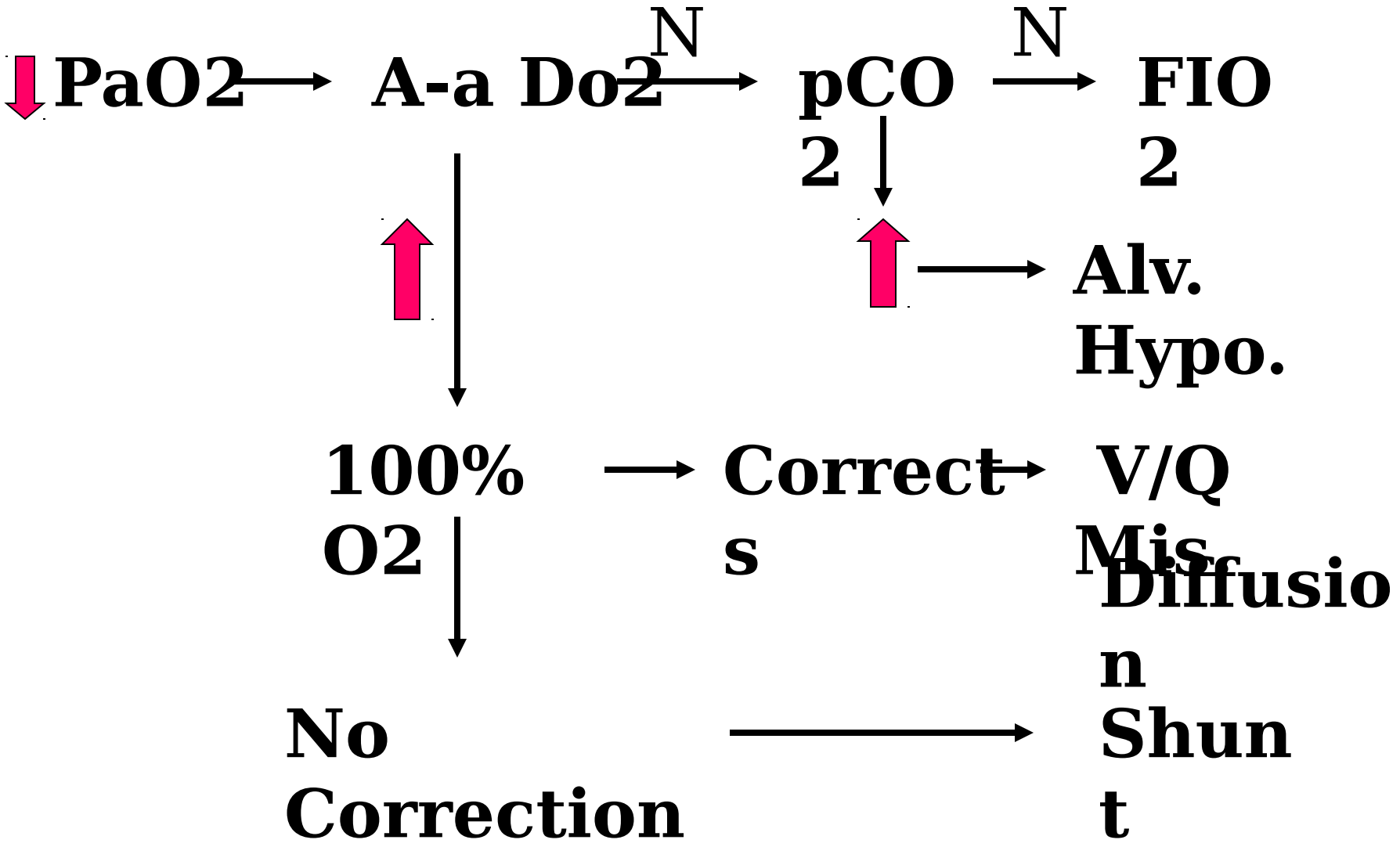
Shunt

- **Intrapulmonary**
  - **ARDS**
  - **Pneumonia**
  - **Pulmonary Edema**
- **Extrapulmonary**
  - **Congenital Heart Disease**
  - **Pulmonary Vascular Disease**
- **% Shunt = (700 -PaO2)*0.05 (Nl < 5%)**
  - **100 % oxygen**

Pitfalls

- **Venous Sample: PaO_2 = 40, $PaCO_2$ = 45**
  - **Free flow into syringe**
- **Air-bubble in syringe**
  - **Falsely elevated PaO_2**
- **High number of WBC**
  - **Consumption by metabolism**
- **Transported on ice under anaerobic conditions**

Approach To Hypoxemia



Problems: Oxygenation

- **Room Air, PaO_2 = 45, $PaCO_2$ =30**
  - **PAO_2 = 150 - 1.2(30) = 114 mm Hg**
  - **A-aDo_2 = 114 - 45 = 69 elevated**
- **100% O_2, PaO_2 = 65, $PaCO_2$= 32**
  - **minimal elevation in PaO_2**
  - **shunt major cause of hypoxemia**
  - **% shunt = 32%**

Problems: Oxygenation

- **Room Air, PaO2 = 45, PaCO2 = 45**
  - **PAO2 = 150 - 1.2(45) = 96**
  - **A-aDO2 = 96 - 45 = 51**
- **100% O2, PaO2 =555, PaCO2 = 48**
  - **PAO2 = 1.0(760 - 47) - 1.2(48) = 655**
  - **A-aDO2 = 655 - 555 = 100**
  - **Dramatic increase in PaO2**
  - **V/Q mismatch major cause of hypoxemia**

OXIMETRY

- **Binding sites for O2 are heme groups**
- **OXYGEN SATURATION**
  - **% of all heme sites saturated with O2**
- **Measures the difference in the light absorbance characteristics between Oxy Hb and Deoxy Hb**
- **SpO2 = $\frac{\text{Oxy Hb}}{\text{Oxy Hb + Deoxy Hb}}$ x 100**
- **ABG SaO2 is a calculated value from PaO2**

Oximetry

- **54 yo WM with headaches, dyspnea and a Kerosene heater at home**
  - **ABG: PaO_2 = 89, $PaCO_2$ = 38, pH = 7.43**
  - **SaO_2 = 98%**
  - **Whats the problem?**

Oximetry

- **Carboxyhemoglobin: Hb +CO**
  - **Does not affect PaO2 only SaO2**
  - **Pulse oximetry reads CO-HB as OxyHb**
- **Follow Up:**
  - **PaO2 = 79, PaCO2 = 31, SpO2 = 53%, pH =7.36**
  - **CO-Hb46%**

Problem

- **42 yo HIV pt with fevers,chills, SOB,cough**
  - **Taking Dapsone for PCP prophylaxis**
  - **ABG: PaO2 82.5, PaCO2 35.2, pH 7.43, SaO2 89%**
  - **PCP Pneumonia, started onPrimaquine, Clinda, and Prednisone**
  - **ABG: PaO2 378, PaCO2 of 35, pH 7.42, SaO2 80%**
  - **Whats Happening?**

Methemoglobin

- Oxidation of Fe++ to Fe+++ state
- Unlike CO-Hb, Met-Hb does depress the SpO2 reading
- Both Dapsone and Primaquine are oxidants
- Met-Hb depresses the SpO2 to 80’s
  - Further increaeses in Met-Hb do not depress SpO2
- Methylene Blue administration is Rx

Co-oximetry

- $SpO2 = \frac{\text{Oxy-Hb}}{\text{Oxy-Hb+Deoxy-Hb+CO-Hb+Met-Hb}}$

ANALYSIS OF VENTILATON

- **$PaCO_2 = \frac{VCO_2 \times K}{VA}$**

  Hypercapnea > 45 mm Hg (Hypoventilation)

  Respiratory Acidosis

  Hypocapnea < 35 mm Hg (Hyperventilation)

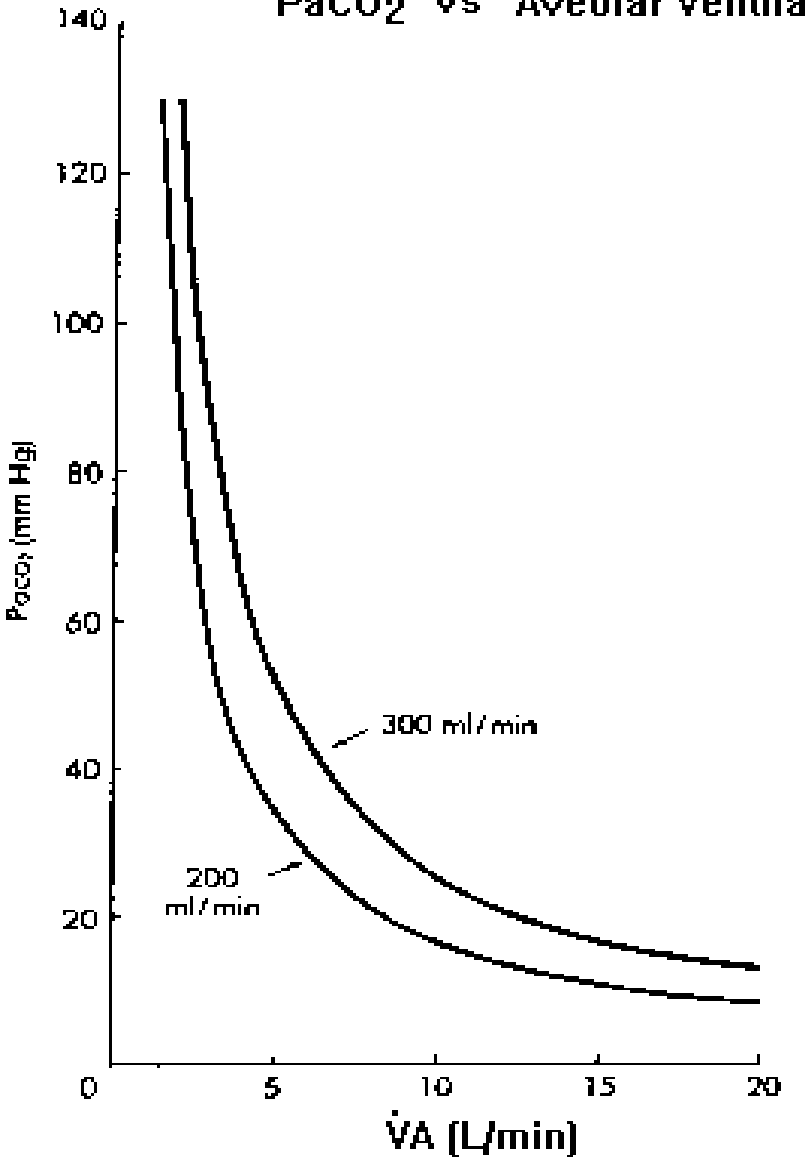
  Respiratory Alkalosis

Respiratory Acid-Base Status

- **Respiratory Disturbances**
  - **$CO_2 + H_2O \leftrightarrow H_2CO_3 \leftrightarrow H + HCO_3$**
  - **Acute changes:**
    - **Delta 10 mm Hg pCO_2, pH changes by 0.08**
    - **Chronic change: 40 + B.E.**
  - **Alveolar Ventilation**
    - **↑VA ↓ CO_2 ↑ pH**
- **Respiratory Acidosis $pCO_2 > 45$**
- **Respiratory Alkalosis $pCO_2 < 35$**

Figure 1

$PaCO_2$ vs Aveolar Ventilation ($\dot{V}A$)



Dead Space Ventilation

- **Minute Ventilation:Volume of air breathed / minute**
  - **MV = VA + Vd(dead space ventilation)**
  - **Increased Vd increases the work of breathing**
  - **MV-PaCO2 disparity**
  - **MV(L/M) PaCO2**

6	**40**
12	**30**
24	**20**

Dead Space Pathology

- **Anatomic**
  - **Rapid shallow breathing**
- **Alveolar Deadspace**
  - **Acute pulmonary embolus**
  - **Decrease Cardiac Output**
  - **Acute Pulmonary Hypertension**
- **Positive Pressure Ventilation**
- **Alveolar Septal Destruction (COPD)**